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SCHOOL HYGIENE

W. E. ROTH

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THE ELEMENTS

OF

SCHOOL HYGIENE:

FOR THE USE OF TEACHERS IN SCHOOLS.

With a Bibliography.

BY

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PREFACE.

THE following pages make no pretence at originality; my object has been to make the subject as concise and intelligible as possible, in order that it may prove acceptable alike to teachers as to pupils with the average amount of intelligence. In the compilation of the Bibliography there have been many difficulties to encounter, but I trust that with regard to School-Hygiene, Scientific Physical Education, School-Construction, School-Diseases, and the medical aspects of school-life generally, it may be found useful to subsequent workers in the same field.

WALTER E. ROTH.

48, Wimpole Street, London, W.
22nd July, 1886.

THE ELEMENTS OF SCHOOL HYGIENE.

It is a matter of practical experience that the **Choice of a School-site** can seldom be determined upon by hygienic considerations solely. The munificence of some philanthropist, the proximity to residences of its scholars, and the value of the land, are among many of the potent factors one has been obliged to contend with, and necessity, rather than option, has thus but too often proved the guiding rule. Nevertheless, we should do our utmost to secure the following desiderata:

(*a*) It is well if protection be afforded from the too direct violence of cold and damp winds. Where the gentle slope of a hill-side can be made use of, many advantages will be gained; otherwise, the planting of quickly growing and hardy trees will prove of great value. According as they are dry or moist, cold or warm, the action of the winds will vary. Cold and dry winds produce a disagreeable sensation on the skin and respiratory organs, and are frequent sources of illness; but cold and wet, they are still more dangerous, resulting often in rheumatism and catarrh. Warm and moist winds tend to check perspiration; on the other hand, warm and dry winds are most refreshing.

(*b*) The soil must be dry and well drained. The presence of ground-water is a subject often totally neglected, or at most only cursorily dealt with, but the intimate relation that has of late years been established between it and certain important disorders, will probably result in greater attention being paid in this direction. It is undisputed that typhoid fever and cholera are closely associated respectively with its fall and rise: when the mean level of the water in question is within six feet from the surface, the site is unhealthy, and must be remedied by suitable means. This ground-water may sometimes be increased and modified by the vicinity of fresh-water swamps or tide-water marshes, which in turn are often themselves aggravated by mill-dams. In the one case, the proper cure lies in the lowering of the water-table in the soil by thorough drainage; while in the latter, simple raising of the ground by filling appears to be the most practicable. Ground-air, though in great measure influenced by variations in the atmospheric pressure, is also intimately dependent on this ground-water. With regard to moisture in the air, a cold dampness very often gives rise to rheumatism, catarrh, chest and abdominal affections, and a very great loss of heat; it hinders the action of the lungs and skin, and is the temperature least suitable for people to live in. A warm dampness is weakening, for it renders the respiration laborious and perspiration difficult, produces dulness and enervation, and is sometimes a great source of danger owing to the production of effluvia from neighbouring marshes. Excessive damp is a predisposing cause of rickets. Accompanied with decrease of temperature, dryness of the air favours respiration, increases the appetite, and facilitates digestion, but only on the condition that the child is able to stand the loss of heat.

(*c*) Other things equal, it is preferable to have the site placed well above the sea-level.

(*d*) The site should be removed as far as convenient from human habitation, and especially from any manufactories, the contiguity of which would be continually evidenced, especially by the organs of hearing or of smell. But when it is practically impossible to prevent such approximation, the height of the neighbouring buildings and walls will have an important bearing on the construction and position of the windows in the class-rooms. For instance, on the ground-floor of the school building we must be able to see a piece of sky from the school-seats farthest from the window; *i.e.*, the neighbouring wall, or whatever else it may be, must be at a distance of at least twice its height away from the school-wall.

(*e*) The position of the building itself is best arranged in such a manner that, speaking generally, its long axis is exposed as much as possible to the sun, while its shorter axis, where the windows are to be at a minimum, faces the direction of the prevailing winds. The direction of the long axis to the north-east or south-west is a very common and good one. In those cases where the school comprises a number of blocks, it is advisable that these buildings be situated parallel-wise, in such a way, that (*a*) no shadows cast from one block may fall on another, and that (*b*) the prevailing winds may be able to act their full *rôle* as air-scavengers along the main lines between them. Fig. 1 will help to make this point clear.

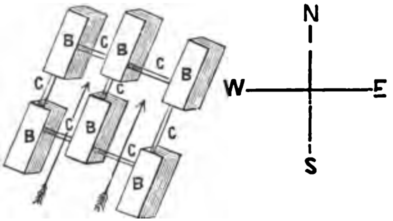

FIG. 1.

B B. The various blocks connected by
C C. The various covered passages.

The arrows show the direction of the prevailing winds. The shadows cast by the various blocks do not interfere with one another.

(*f*) The shape of the site is, of course, dependent on the local conditions, and on the special kind of school to be built. Thus we may have it constructed on a 'corridor' system, where the class-rooms are given off from one or both sides of a corridor; or on a 'compound' system, consisting of a square building with central enclosed area or quadrangle; or the school may be built in blocks. It is advisable for the kitchens and bedrooms to be on top floors.

Before being actually built upon, the whole surface of the ground should be covered with concrete, and thus the proper ventilation of the space under the ground-floor well ensured. The **building materials** will vary greatly with the geological formation of the neighbourhood and cost of transit; their hygienic essentials are that they be easily cleaned, non-absorbent, and durable; and of all materials, those only which fall within the usual limits of expenditure, and yield the best results, are brick and stone. 'Where bricks are not used, a very careful selection of the stone must be made, as, especially in towns, certain varieties crumble and decay under the influence of the acids which are suspended in the air.' It is stated that Portland cement, when mixed with a certain proportion of sulphur, is rendered fire-proof. With regard to woodwork, no wood is to be employed that has not been previously treated with the necessary chemical re-agents, with a view to the prevention of rotting, which is due very often to 'merulius destruens,' or 'lacrymans': it should also, in addition, be painted with 'cyanite,' 'asbestos,' or other fire-proof paint. All wood that is exposed should be varnished, varnish being non-absorbent and very easily washed and cleaned. In all cases it is essential that good ornament should invariably be associated with, and form an integral part of, the real construction of the building.

The **external walls** are best constructed hollow, a space of about two and a half inches being allowed for, with proper damp-courses of asphalte or slate. The advantage claimed for this method of construction is that it tends to keep the enclosed rooms warmer in winter and cooler in summer. Under certain circumstances the damp-courses may serve as ventilators, the air which enters through the outer wall on a level with the floor passing in through the inner wall at a few inches' distance from the ceiling.

Partition-walls are to be of solid construction, and not of the ordinary common lath-and-plaster kind.

'A flat **roof**, covered with cement concrete and a thin coating of genuine mastic asphalte, appears to be preferred, in that it gives a more even temperature to the roofs under it, is suitable as a pleasant place of recreation and of astronomical observations, and is cheaper of construction than an ordinary or tiled roof.' Its edges must be well protected.

The **main entrance** should be on that side of the building least exposed to the prevailing winds, and will vary in dimensions with the number of pupils that have to pass through. One architect, who takes four feet as a minimum width of entrance for fifty scholars, increases it by one foot for every fifty additional. Situated then in the proper quarter, the main entrance-door may be left open during school-hours throughout the summer-time, but in the winter months it will be convenient to have swing-doors substituted.

All the *passages* must be made absolutely damp-proof; this can be best done by 'putting down Portland cement, concrete size, or eight inches thick, finished off to a fair surface so as to form an even floor, and not, as is often done, finished with a thin layer of finer cement over the concrete bed, which by-and-by is sure to peel off and leave a rugged and uneven floor.' There should always be a large window at each extremity of a corridor.

Passage-walls are as far as possible to be lined with light-coloured glazed tiles, which are cleanly, absolutely non-absorbent, reflect and give light, are easily washed, and tend to make the building sweet and healthy. It may be remarked that the passage-wall surface should have no projecting buttresses.

No school is to be built without a **playground**: this is as essential as the steam to a locomotive. The size of the ground will be dependent on the number of pupils—four square yards to each scholar being a fair allowance. The surface should be as level as possible. The nature of its soil will, of course, vary with the locality; ordinary turf is about the best. Sand should never be laid down, as its use in hot and dry weather is very liable to produce injury to the eyes, owing to distribution of the minute particles into the surrounding air. Where necessary, fine gravel, crushed shells, or asphalte, have their advantages; rough stones on no account—the temptation to use them as missiles of offence is usually too great.

In any case the ground should be well drained, but care must be taken never to have any open sluts, as dislocations, ankle and knee-injuries, are then very liable to occur. With regard to the limits of the playground, it were better to trust to the honour of the pupils not to transgress its borders—indicated maybe by a light railing, fencing, or shrub-work—than that recourse should be had to the ordinary prison style of wall. In certain cases, depending, for instance, on the neighbourhood of other habitations, etc., there may be an absolute necessity for enclosing the playground-space with walls, and the following requirements may then be attended to. As regards height, the walls must be such that they cannot be scaled, and on this account should, if anything, be built projecting slightly inwards: their tops are to be free from *chevaux-de-frise,* pieces of broken glass, and other mediæval contrivances. It is far more hygienic to the eyes to see shrubs or plants trained along their borders, than to gaze upon the cold, bare surfaces. Where necessary, all buttresses must be on the outer side, and in those cases where the shape of a playground does not admit more or less of a rectangle, any projections should be rounded off. A very common cause of accidents in playgrounds is the following: a little fellow is hotly pursued by one of his companions—he turns his head to measure his distance, and suddenly finds himself violently struck by a wall, tree, giant-stride, or other apparatus there may be present. To prevent this source of accident, I propose to have all such playground accessories surrounded by sloping terraces, which will not only break the speed, but at the same time act as a signal of warning to the child pursued. (See Fig. 2.)

In no case is the ground to be divided or partitioned off by a low hand-railing, as was the case in a school of my own experience, where three wrist-dislocations took place in less than as many weeks, from the sudden way in which it arrested the child's progress when being chased. For wet weather a covered playground is to be provided, with the light if possible falling from above, and the pillars, if any, supporting its roof furnished with the terraces already described. The object of having a *playground-master* is to see that no unnecessary violence or bullying may take place; to have a care that all backward, timid and nervous pupils take their fair share in the games and recreation; and to teach the children how to play. This almost sounds a paradox, but it is true that playing is an art in which children have to be taught. The master will also of course join, whenever possible, in all the games, and be ready to meet an emergency in case of danger or even of accidents. In addition he will try the ropes of the various swings, giant-strides, and other apparatus, before allowing of their use by the children; and will see that violent games are not carried too far so as to prove sources of danger; he ought also to discourage the use of pea-shooters, catapults, etc.

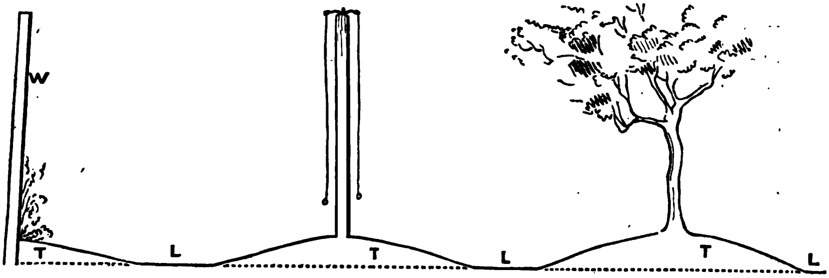

FIG. 2.

DIAGRAM OF A GOOD PLAYGROUND.

T T. Sloping terraces round a tree, giant-stride, and wall.
L. Playground level.
W. Boundary wall, projecting slightly inwards, and along which shrubbery is trained.

Far too little attention is paid to the **staircases**, which are, indeed, about the most important constituents of a school building, and which are only too often badly built and insufficiently lighted. The most common accidents resulting from their defective construction are due to inherent restlessness, curiosity, and perhaps mischief; and we have hence, first and foremost, to see that the height and make of the balustrades are such that the children are prevented from climbing over or getting pushed through, were one of the bars to give way. Long straight stairs are to be avoided, for a long continuity of steps is tiring and more dangerous in cases of slipping and tripping up, than in those cases where the number of steps of each stair is limited by means of landings, of which there can never be too many. The stairs should never be directly opposite a door, and their good lighting is extremely necessary. The same principle which is taken to guide us in determining the width of the entrances, is made use of in fixing the width of the staircases. The edge of the steps may be made still firmer by a slip of iron, the step itself being built of the same durable materials as those composing the passage-floors: the height will vary with the particular portion of the building, from four to six inches, according to the younger or older children using it. The depth of the steps from before backwards can be advantageously increased from twice the height at the top of the stair, to two and a half more times its height at the bottom; this arrangement has the advantage of lessening the wearisomeness in ascending, and reducing to a minimum those accidents resulting from a precipitate rushing or sudden pushing in descending. A projecting edge to each step increases the risk of tripping up when ascending. There should be a hand-rail on either side, the height varying with the mean average height of the pupils using it; the rail on the outer side being provided with smooth knobs, for the purpose of preventing any sliding or other gymnastic performances. The vertical bars should be perfectly straight, with no ornamental iron-work binding them together, such contrivances only acting as aids to the children when attempting to climb over. The distance between the bars is to be such, that if by any chance one bar were suddenly to give way, the distance between the two remaining ones would be too small for any of the pupils to get through. (See Fig. 3.)

Order on the stairs and in the passages may be maintained by the system of having the bells rung twice at each change of class; the first ringing is the signal for the monitors to leave their respective classrooms, and take up their previously arranged positions at various points on the landings and corridors. Traffic is thus regulated and unnecessary pushing and crowding prevented, by the simple expedient of making the up-stream of pupils pass on one side of the staircases or passages, and a down-steam on the other.

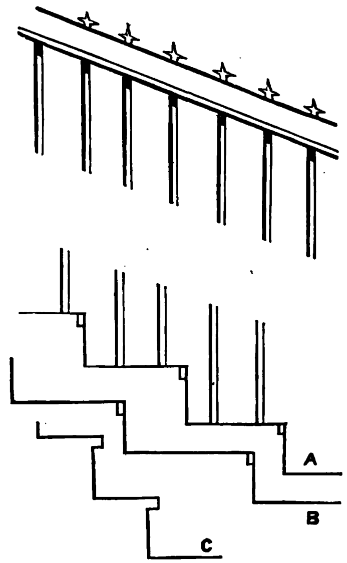

Fig. 3.

A. Steps at top of a staircase.
B. Steps at bottom of a staircase.
C. A bad staircase.

N.B.—The knobs in reality on the balustrade are not so dangerously spiked as represented.

Dimension and Construction of the Class Rooms. — It is of great importance that schools should be constructed with some reference to acoustic principles if there be any, and if they do not exist, that architects should direct their attention to the subject and see whether they cannot find out the difference between buildings which are, to use a popular phrase, good or bad for sound.

All corners are to be rounded off with a view to preventing the accumulation of dust particles; for the same purpose it is advisable that all cupboards, etc., reach the whole height of the wall surface, or at all events be inserted into special recesses of the walls built to receive them, rather than that they should stand out as projections. Buttresses also are liable to be productive of accidents. In fixing the length of a room, care must be taken that the various explanations of the master be audible, and the diagrams, etc., visible, at the farthest end of the room. Speaking generally, a floor-space of one square yard for each pupil is a minimum allowance; at any rate, we must insure that for every occupant there may be provided an air-space of 200 cubic feet. The number of pupils in each class will vary from twelve to eighteen for very young children, to thirty or more for elder ones: these figures are of course arbitrary, and will be dependent on local conditions, and especially on the fact that the more youthful the child, the greater are its temptations for distraction and want of concentration.

In the matter of **ceilings** a more extensive use of fibrous plaster should be encouraged; if necessary, it can be modelled to any design, and be screwed to the joists. 'It is infinitely better than the old system of lathing and daubing two or three coats of heavy plaster on to our walls and ceilings, for owing to its strength and tenacity it has no liability to crack, is virtually fire-proof, is rapidly fixed, can be decorated within a few weeks, and saves all the dirt and mess, which, unless great care is used, absolutely destroys all floors if they are required to be stained or varnished, for the spots formed by the dropping lumps of wet plaster practically will show through any amount of stain or varnish.'

The **wall surface** must be bright in order to reflect the light properly, but not so bright as to dazzle the eyes; further, it is to be durable, cleanly, washable, non-absorbent, and of a suitable colour. If paper-hangings be used, they may be made washable at a very small extra cost, but great care should be taken in their fixing by the proper kind of materials, for the smell of bad paste is not a pleasant one, and is frequently a source of considerable annoyance for a long time after. We must avoid all flock-papers and raised patterns, which only help to accumulate dirt and dust; also all those into the preparation and manufacture of which enter any hurtful ingredients, such as arsenical compounds and various lead preparations. Washable distempers, like the 'Duresco' and 'Calcarium,' are excellent; and besides, their colouring matter does not rub off on to the clothes, or into the air as dust. 'In order to be healthy and cheerful, colour should be æsthetical; that is, in true accord with right perceptive feeling —in accord with nature, from the study of which all our best colouring is derived. We need not for daily use gaudy and startling effects, nor yet a dull monotony, but colouring of such force and variety as shall be essentially cheerful and agreeable. Hence we see that the employment of colour is not a matter of mere option or of taste, but of healthful, cheerful, and wise enjoyment.'

The colour of many pigments mixed with oil deteriorates, it fades or becomes darker; 'Crete-enamel' keeps its freshness longer than paint. A varnished wall surface loses its clearness and freshness in the course of years, though still retaining a pleasant tone; it is otherwise of the greatest value on account of the ease with which it may be wiped down and kept free from the accretion of dust. There have been invented a variety of damp-proof paints for interior surfaces of questionable value in this especial respect, seeing that damp should be kept from penetrating from the outside, and not be merely covered up from sight within. A bright grey, a pale blue or green, or a light brown, are very good colours for schoolroom walls.

A **wainscoting** or **panelling** is unnecessary, and, unless painted with cyanite, asbestos, or other fire-proof paint, a possible source of danger; from a hygienic view, such an arrangement is bad, owing to the liability of harbouring damp and stagnant air.

The **schoolroom doors** are best constructed on a system such as the 'Norton,' which allows of their shutting automatically and silently. When opening into long corridors the insertion of a couple of ribbed or ground-glass panes in their upper half will prove of material assistance in lighting up the passage. The doors must all open outwards.

The value of '**blackboards**' in the schoolroom is a dubious one, so far as regards the nature of its colour; a white composition slate has lately been invented, and which has proved a great success. At any rate, care must be taken that it does not present a shining surface, is not fixed in too dull or too dazzling a light, and never placed on the same side of the room with the windows. Even nowadays, it is not of uncommon occurrence to see the blackboard placed on the wall between two windows, and the children, with the glaring light falling straight upon them, straining their poor little eyes to make out what is written. The introduction of the 'continuous' blackboard, arranged round three sides of a room, has been shown to be very advantageous. The use of yellow chalk is perhaps preferable to the white variety.

On the wall facing the teacher, and hence behind the scholars, should be placed a reliable **clock**, with no loud ticking action, and well out of ordinary reach. There should be a **daïs** for the teacher.

A plain flat **floor** is preferable to the stepped variety, which is inconvenient in that all the desks have to be fixed, and anomalous in so far as the movement of stepping up and down is concerned, the measurements of the desks fixing the depth of each step; furthermore, a stepped floor is unsanitary, because the cubic space of the room is thereby greatly diminished. Carpets must never be used. 'Parquet forms a very good material for floors on account of the absence of any crevices or chinks that might otherwise collect the dust and dirt.' There are some 'hygienic' parquets and movable floors made, where the worn parts of the inlaid floor can be removed and substituted by those which have not suffered by the continual wear; they can be cleaned by a good washing, removed and replaced without any difficulty, and can also be fixed on pavement without the use of joists. Wood-block paving, *i.e.*, blocks about 9 × 4½ × 1½ inches, laid solid in pitch on a level cement bed, has been recommended as a means for materially diminishing the noise.

Directing our attention now to the **lighting apparatus**, we will consider the means best adapted for obtaining and regulating the proper amount of light necessary in the schoolroom. The agency of windows with daylight is the first to suggest itself, and this has been applied in three different ways:

In the (*a*) unilateral method, the light must fall on to the scholars exclusively from the left-hand side and from above. Great caution should be exercised with the (*b*) bilateral system; it may only be adopted as a last resource when sufficient open daylight is out of the question, or when it is absolutely impossible to obtain the necessary proportions between the height of the windows and the size of the rooms; but even then the plan is inconvenient, in that the two lights are always interfering with one another. The principle (*c*) of receiving the light from the top, in the way of skylights, is very good as regards the amount of light provided, though the objections that have been urged against it are that, on the one hand, it collects the snow in winter, and on the other, makes the air beneath too suffocating in summer; suitable blinds are the remedy in the latter case.

In illumination from the one side, which after all is perhaps the simplest and the best, there is a little doubt as to the requisite distance of the upper border of the windows from the floor; one authoritative opinion is that this should be equal to the height of the room, while another is that it be three-fifths the breadth of the room plus the thickness of the wall. The lower boundary of the window should be on a level with the heads of the pupils when seated; if too low, the light is thrown into the eyes from below. The ratio between window-superficies and floor-space should be as one to six at least.

To screen too dazzling a light, nothing can be better than a simple grey linen blind, fixed, according to an American patent, in half the height of the window, so that either the upper half, the lower, or both, may be shaded. Venetian blinds, heavy curtains, etc., are to be avoided, owing to the dust clinging to them. The windows are to be as widely splayed inside as possible.

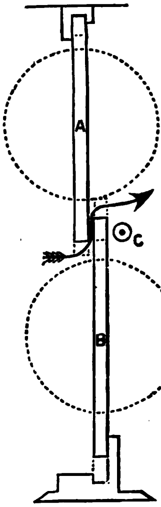

FIG. 4.

A B. Upper and lower sashes.
C. Bar for the blinds fixed midway.

The arrow denotes ingress of the air. The circles indicate the revolving motion of the sashes, for purposes of cleaning, etc.

In order to obviate the large number of deaths annually met with by people cleaning windows from the outside, the sashes should be built on the 'anti-accident' type, which, in addition to the ordinary vertical movements, allows of a revolving motion round a fixed centre. See Fig. 4, which also shows a useful addition, in the shape of the beads of the window-frame being made three or four inches deep, so as to prevent appreciable draught. Instead of the ordinary miserably thin glass, we should use thick plate, which gives 'truer light,' is less penetrated by sound, and helps to retain the warmth of the room after the fires have gone out.'

With regard to artificial lighting by electricity, there can be no doubt that Swan's incandescent or some similar system, when properly arranged, is incomparably superior to all others. There is a constant steadiness about it, and the pupil is thus enabled to work without the inconvenience and fatigue occasioned by a flickering light. The colour, on analysis, is seen to contain a minimum of red and a maximum of violet rays —thus, of all other illuminants, forming the nearest approach to daylight. Of all artificial sources of light, it radiates the least heat, and gives rise to no deleterious products of combustion. The following is a description of the method adopted in a schoolroom (13½ × 26½ yards) of a school well known in Liége, to the lighting of which electricity has been applied. 'There are two electric sun-lights fixed to the lower ends of iron rods which hang half-way down into the room. Underneath each sun-light there is a concave mirror, one side of which shades the light from view, while the other throws the light on to the whitewashed ceiling. From this it is reflected throughout the room. Thus the light comes from above, and falls in pretty well equal degree upon all the desks, while the sources of the light themselves are invisible. The light is quite sufficient, but not at all dazzling.'

The danger of explosion, and regulation of the flame to prevent smoking, militate against the use of petroleum, which, except for these drawbacks, is the next best illuminant.

With regard to gas, to avoid heat-radiation of the gas flame, it should be placed at least forty inches above the heads of the students, and the speedy removal of the products of combustion well effected. 'Candles are so dear that they cannot be thought of as the illuminating material on a large scale.'

'If we always adopt in schools the best mode of lighting that can be obtained, we not only spare the children's eyes, but we also gain a further advantage. Children who are accustomed to work in school in a good light, will endeavour to procure the best possible lighting at home.' Except to those who happen to have paid attention to the subject, the number of injuries, complaints, and diseases of the eyes arising from defects in the lighting arrangements would appear almost incredible.

The most important essential of any **heating apparatus** for schools is that the noxious products of combustion be removed as speedily as possible, and that no wood-work in the vicinity be exposed to the risk of catching fire. In institutions for very young children there should be a tendency to avoid all apparatus from a too close proximity to which they have not yet learnt to expect injury or accident: in these cases, the method of introducing air already heated into the rooms is a very good one, and a description of a very simple form of combining it with ventilation is the following: 'A furnace, surrounded by brickwork or iron plates, is erected in the cellar communicating with the open air through a sufficiently large duct. The air is heated by the furnace, and led into the rooms through channels, which may be either constructed in the walls when the houses are built, or made of thin iron plates if being fitted into old houses. The fresh air, besides being heated, may also be supplied with a suitable amount of moisture from water-basins placed above the furnace. The fresh air entering the room will in time sink down towards the floor, and finally escape through the chimney.'

On the other hand, the warming of the schoolroom can be advantageously effected by closed stoves, open grates, or pipes; a combination of the two latter together is seen in the 'tubular water-bar open fire-grate' and the 'coil-grate' systems, where the pipes are arranged in the form of bars as in an ordinary grate. There has been invented an ingenious system of combining the warming of the school-buildings with the electric light by means of exhaust steam; this is a process—the 'Reck' system—which at the same time remedies the defects due to warming with steam by itself, such as the great waste of heat at places outside the localities to be heated, and the absence of heat when most required, *i.e.*, in the morning.

Ventilating Apparatus.—The chief vitiations of the air in a class-room which it is desirable to remove are those produced by the accumulations of individuals, the putrefaction of suspended organic particles, the presence of heating apparatus, and the injurious emanations from the vicinity, maybe, of any manufactories, cemeteries, marsh-lands, etc. The various machines and appliances that have been proposed to effect this are usually divided into two categories, the natural and the artificial; but the distinction is quite arbitrary, and had better be discarded.

Ventilation without draught appears to have been accomplished by the lately devised syphonic system, of which the following is a description: 'The air-supply is conducted into the apartment from the external atmosphere by means of air-ducts, which terminate in distributing-passages at the floor-level. The exit for the vitiated air is placed in the ceiling, and consists of two tubes, a large and a small one, running parallel to each other, between the floor-joists in the case of rooms having others over them. In the case of rooms on top-floors, or those having the roof directly over the ceiling, the tubes are placed concentrically, but the action and results are the same. The larger of the two tubes carries off the vitiated air, while the smaller one forms an induction-tube for cold air, its outer extremity being open to the atmosphere. These two tubes, or conduits, are so connected that the passage of the heated air through the larger tube induces a current of cold air through the smaller one in a continuous stream. The result is a rapid clearing away of all deleterious gases and products of combustion as they accumulate, and the preservation of a pure atmosphere, at an equable temperature, in the apartment.'

Of the ordinary processes in use, may be mentioned the method of having a smaller flue running alongside the chimney, and into which the vitiated air of a room may be aspirated; but the objection to this is the production of more or less draught. Similar faults may be urged against the so-called 'chimney-breast ventilators,' fixed over the mantelpiece, and the 'tubes' placed in the corners of the apartment.

It will be evident that in seasons when the temperature of the external air is terribly low, the syphonic system is hardly applicable; recourse must then be had to combining the ventilation with a warming apparatus (see *ante*). There are certain coal-stoves which, besides making provision for the egress of foul air, have an arrangement whereby the ingress of warm and fresh air from the exterior is ensured. Another form of apparatus has hot water for the heating agent. In Benham's 'ventilating globe-light pendants,' gas-light is used, the bad air of the room being aspirated to the exterior inside along the chimney; they answer the purpose extremely well. Fig. 5 shows the working of the system to be as follows: As soon as the burner is lighted, an upward current is created in the inner tube; this becomes heated, and rarefies the air in the larger or outer tube. The air in both pipes is conveyed to the chimney of the room in which the pendant is fixed, thus producing two distinct actions, viz., the entire removal of the carbonic acid gas and other products from the burner, and also a gentle movement of the heated and vitiated air of the room to the chimney of the apartment, or to a shaft specially prepared for the purpose. The pipe D is used to introduce a current of cool external air, to supply the place of that which is carried off by the hot-air pipes, and also to assist in producing a derfect combustion of the flame when the gas is burning.

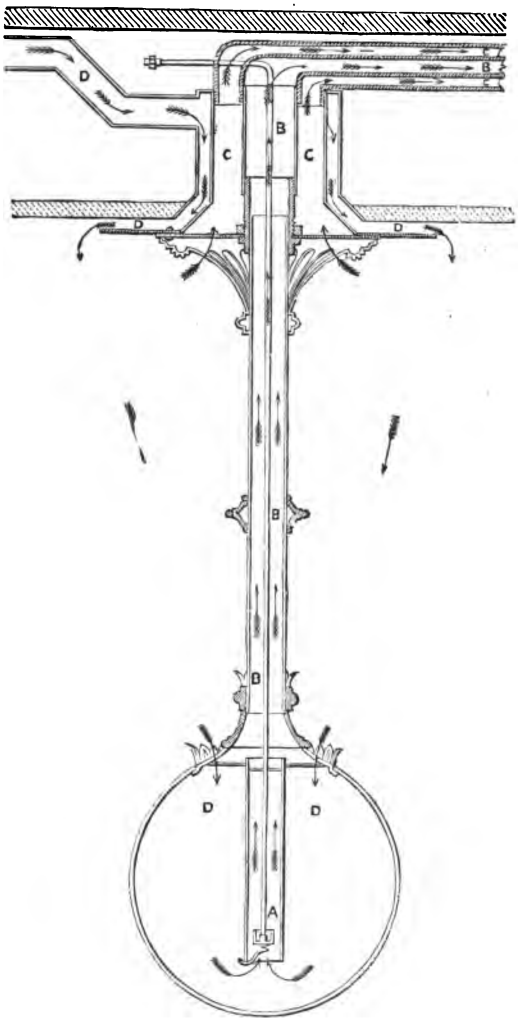

FIG. 5.

A. Burner, and gas-pipe to supply the same.
B B. Pipe to carry off the foul air from the burner.
C C. Pipe to carry off the heated air of the room.
D D. Inlet for cold external fresh air.

The arrows show the direction of the currents of air when in operation.

The Desk and Seat.—Though the old-fashioned unbacked bench, fixed behind a long low desk, has over and over again been condemned, it has only in a few instances been replaced by a more advanced or more hygienic appliance. In England it is still to be found in certain of the public schools, in the majority of private ones, and in all village and parish schools. The various forms of spinal curvature, round backs, narrow chests, and all other concomitant complaints, have not hitherto proved sufficiently forcible arguments to principals, managers or masters of schools, to seek a remedy for these defects, of which complaints have only too often been made in vain. Expense, the want of space, and trouble to the teacher in having to render his voice audible over a larger area than that which he otherwise considers absolutely necessary, are said to be among the chief factors in opposition to the introduction of a single desk, and a single seat, for each individual pupil: the present accommodation and present expense would also have to be increased. Although the national importance of each child having a good chair and a good desk is fully recognised, it certainly does seem strange that rational beings should consider any sacrifice too great in matters where the health of coming generations is at stake. The introduction of the 'dual' desk—a desk and seat for two pupils—into certain schools, is a step in the right direction, though very far from perfect.

It cannot be too often repeated, that each pupil must have his own desk and seat, of which the following should be the essentials:

(*a*) The height and depth of the seat must correspond with the length of the legs (below the knees) and the length of the thighs. On looking over the seat arrangements of an ordinary common school, one cannot fail being struck with the persistent narrowness of the seats—a cause of the uncomfortable tingling or going to sleep of the legs, produced by unusual pressure on the nerves. A vertical motion of the seats is sometimes allowed for.

(*b*) The seat should be horizontal, and perfectly cane-bottomed; the support for the feet is advantageously placed at an angle of 30°, or a little more. This will form a very comfortable position to rest the limbs in.

(*c*) The back of the seat is to be formed of a lower convex and upper concave portion; the latter contrivance is intended to receive the convex portions of the shoulders, while the former, in the shape of a movable cushion or pad, is made to act as a support to the lower part of the spine.

There is a movable cushion or pad, which may be regulated and fixed by a screw, in the 'Adjustable Modern' desk; in other cases, support is given by a fixed convex back, as in the 'University' desks, and in the 'Borough dual Board School' desks.

(*d*) The desk ought to be movable in a horizontal direction, so that it may be brought to within a distance of one or one inch and a half from the front of the body, thus enabling the pupil to place both forearms equally on the slanting desk and to write without changing the good or normal position of the body. The manufacturers of the 'Louise' and 'High-School' single desks have evidently paid attention to this particular.

The horizontal motion of the desk is utilized in allowing the pupil either to stand upright, or to leave and return to his seat. The same purpose may be effected by other agencies; thus, the back portion of the desk-top may be made to fall down, as in the 'East-Anglian' and 'Boys and Girls'' desk, or to turn up and then act as a reading-desk. In one improved school desk, although a folding-up desk, it is impossible for the scholars to get their fingers between the parts folding up, and those remaining fixed, as it works not on a hinge, but around a centre. Or again, the seat may be slid back horizontally, or revolved so as to fall upwards and backwards; the latter movement is sometimes effected by means of a spring immediately on the pupil rising, but such springs are all liable to get out of order with school wear. A very favourite desk, judging from the numbers in the market, is that which is built on the 'convertible' type, where the apparatus can be changed from a backed seat into an unbacked desk, by means of different mechanical arrangements: such, for instance, as the 'Reliance,' the 'Yorkshire,' the 'Southwark,' or the 'East-Anglian' convertible desks. Amongst the drawbacks to these 'convertibles' must be mentioned the necessity of continually taking out and putting in the ink-pots according to the purpose for which the desk may be required.

(*e*) The inclinations of the reading and of the writing desk, should be different; for the former a slope of 40°, for the latter 15°, have been found most advantageous.

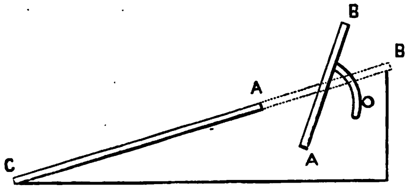

FIG. 6.

It is of common occurrence for the reading-desk to be formed out of the back portion of the desk-top when turned up, or may be separately constructed. In the latter form, it can be fixed, when necessary, into holes on the top of the writing-desk; it may also be made of a board equalling in length that of the desk-top, on the sides of which it works in a groove, so as to be slid backwards or forwards, according to the distances required. Again, a special movable reading desk may be made use of (Fig. 6); the front portion, A B, is that which revolves to form the reading-desk proper, which is fixed at what is considered to be the correct angle, while the hind portion, C A, is fixed to keep the pupil at the requisite distance from the book.

(*f*) The seat and desk being built for the pupil, and not *vice-versa,* must be fitted at regular intervals—a very good plan is at the commencement of every school year.

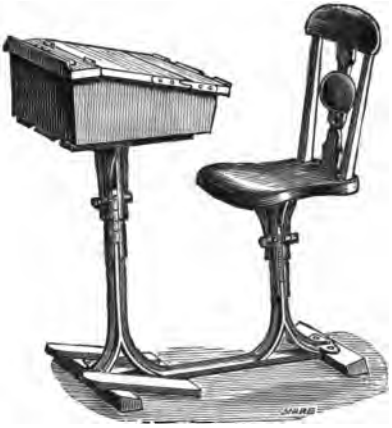

FIG. 7.

THE 'MODERN ADJUSTABLE' DESK.

Such being in short the requirements of a good school desk and seat, attention should be paid to finding the best

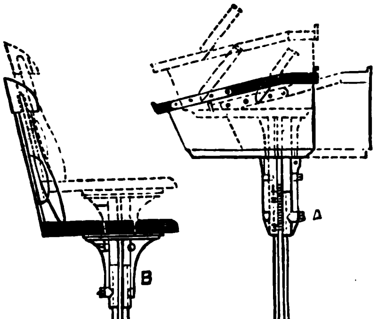

FIG. 8.

THE 'MODERN ADJUSTABLE' DESK, SHOWING MOVEMENTS.

Explanation.—1. By the application of a key to A and B, the desk and seat may be raised or lowered to any desired height. 2. Desk top slides horizontally. 3. Writing slope at 15°, reading do. 40°. 4. Hygienic chair, with adjustable spine-pad.

apparatus for fulfilling all the above conditions; taking everything into consideration—strength, neatness, simplicity of construction, and comparative cheapness—the patent 'Modern Adjustable' manufactured by Mr. Glendenning appears to answer all the requirements. (See Figs. 7 and 8.)

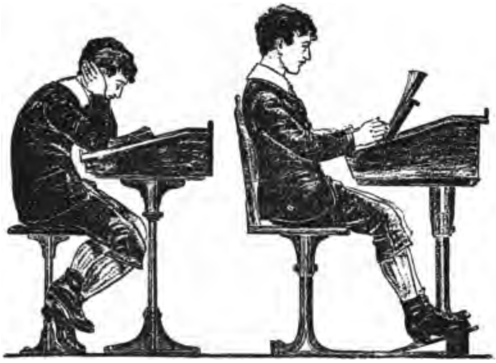

FIG. 9.

In comparison with 'dual' desks, however hygienic and scientific their construction, the advantages of single desks are that they are lighter to move, for cleaning the floor; more

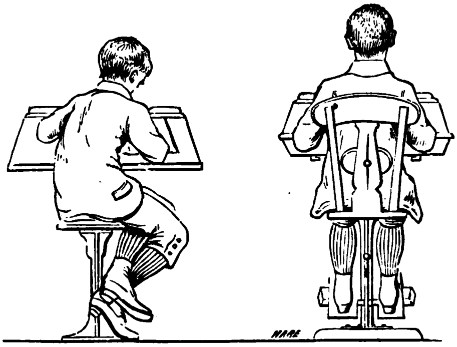

FIG. 10.

readily admit of a change in the shape of a class; lessen the probability of copying and the temptation to do so; give an interest and even pride in the desk; stimulate tidiness and fix untidiness upon the right shoulders. To prevent 'cribbing' on the 'dual' desk arrangement a board has been made to stand up vertically, and thus partition off the two desks: the method however, is bad, in that the light is prevented from falling in the proper direction on to one or other of the desks. Figs. 9, 10, 11, show diagrams of bad and good positions when reading, writing, and piano-playing.

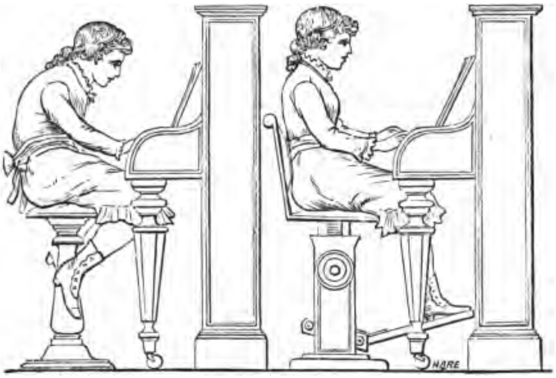

Fig. 11.

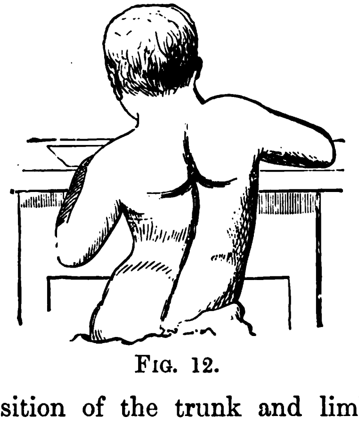

Fig. 12.

The good position of the trunk and limbs having been secured, it will be well now to consider what are the additional requirements necessary for maintaining that position during writing. The **bad postures** generally in vogue—the twisted head and neck, the raised right shoulder, etc. (see Fig. 12) which it is imperative to avoid, are dependent primarily on the three following facts:

(*a*) That the child fixes its eyes on the thick strokes of the written characters;

(*b*) Not on the hair-strokes, the terminal point of which is the only portion it pays attention to;

(*c*) And that the general nature of the handwriting is a sloping one.

The remedy lies in teaching the child, either an upright handwriting, or a sloping writing under given conditions. In the former, the thick strokes are perpendicular to the lines, which are kept parallel with the edge of the table by having the copy-book straight in front of the middle line of the body: various objections, however, have been urged against this method, which, though good, is certainly not to be preferred. A sloping handwriting, when performed under the following conditions, will admit of a normal posture of the head and shoulders. The copy-book is to lie in front of the middle of the body so that the lines run up from left to right in a slope of from 30° to 40°—the proper slope being obtained when the thick lines of the handwriting are perpendicular to the edge of the desk. Sloping ruled lines in the copy-book should be dispensed with, the children being thus forced to look more closely.

There are some specially **bad positions of the arm and hand** whilst writing, and amongst the bad modes of holding the pen may be mentioned the following. Instead of holding the pen between the thumb and middle-finger, with the fore-finger gently placed in a semi-extended position on the pen, many writers press very strongly on the pen either with the thumb—thereby causing indentures on the side of the middle-finger and on the lower surface of the top joint of the fore-finger—or with the fore-finger, which causes the second joint to form a right angle, and the third to form an obtuse angle on the back of the pen, as shown in Fig. 13. Again, instead of gently supporting the writing hand on the little finger, in the longitudinal direction of the forearm, many persons curve the wrist, with convexity of the back of the wrist and hand, as seen in Fig. 14; instead of writing in the usual way from the left to right, and from below up, these people write straight up and down, and instead of using only the fingers, they move the whole hand and part of the forearm.

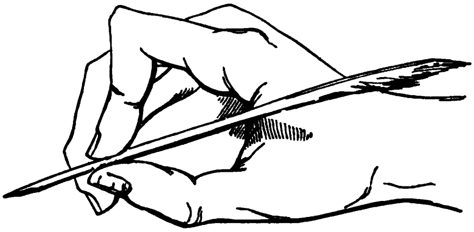

FIG. 13.

The position of the body while writing should admit of the trunk leaning against the chair, both forearms supported on the inclined desk. In the majority of cases, children are still taught to place the paper straight before them, and slightly opposite the right half of the chest; their body is thus twisted into an unnatural position, and a great part of its weight thus thrown unnecessarily on the left forearm.

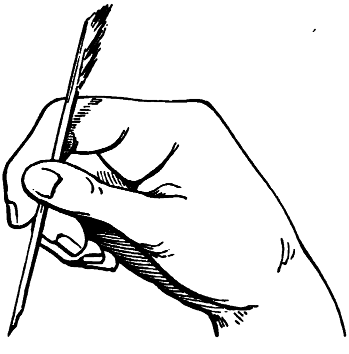

FIG. 14.

In the ideal school, instruction in writing would be preceded by instruction in drawing, thus exercising the muscles entirely, 'until the hand became so flexible that it would form a stroke of any length and of any degree of firmness before the writing-instruction proper was begun.' The natural outcome of this would be the early teaching of shorthand, and thus the valuable time subsequently too often wasted in taking down exercises, lecture-notes, etc., considerably diminished. Children should be taught to write equally well with the left hand.

The folding of the arms over the chest must never be tolerated under any conditions whatever.

In common with the hygiène of writing and of reading comes naturally the choice of the **proper colour and texture of the paper.** Speaking generally, the thickness is to be such, that when superimposed on a white surface, that which is written or printed on the under-side of the paper shall be invisible on the upper. The paper itself must have a smooth, dull, unglazed surface, so that the pen may have an easy, gliding motion, and never get the chance of spurting ink while attempting to leave a mark on those parts which, owing to the scholar's hand, would otherwise often become greasy: the child is many times blamed unnecessarily and through no fault of its own. Hygienists are at variance as to whether the colour of the paper had best be white or of a uniform yellowish tint; the latter appears to me preferable.

Concerning the use of ordinary slates, it has been shown that so far as regards visibility, writing on the slates is to writing with ink on paper as 3 is to 4. This, together with the shiny surface of the slate, causes the writing-scholar to assume a bad posture.

With regard to the **pen**, the cramping and tingling in the fingers of a beginner, due to unnatural pressure on a hard and thin penholder, can be avoided by the use of a stout cork one, which in addition is cleanly, in that any ink-blots on the fingers may easily be soaked up. The length of the holder has a minimum of twice the length of the fore-finger. The steel nib is preferable to the quill; blotting-paper must never be substituted by sand.

The principles that have been laid down for the **print of a school-book** are as follows:

'(*a*) The height of the *n*, which is taken as the standard of measurement for the height of the whole printed matter, is to be at least 1·5 mm. (the so-called "Corpus" type).

'(*b*) The thickness of the *n*, at least 0·25 mm.

'(*c*) *Approche*, at least 0·75 mm.

'(*d*) Interlineage, at least 2·5 mm.

'(*e*) Length of lines, at most 100 mm., with not more than 60 letters in a line.

'Children have, as a rule, greater acuteness of vision than adults, and hence letters are visible to them at a greater distance. On the other hand, lines of printed matter must be brought closer to them than to adults in order to be legible, as children have had less practice in distinguishing by means of the "apices" (cross-strokes at the ends of the hair-strokes) certain letters, otherwise alike—for instance, E and F—and consequently the print of books ought to be larger for the first years of instruction than for the later ones.'

From a hygienic point of view, one cannot fail being struck with the idea that the manufacturers of the ordinary **hat, cap, and cloak-stands**, or rails, are ignorant of the purposes to which such articles of school-furniture should be applied. In the large majority of cases, the pegs are placed too close together, and are in addition fixed more or less vertically one above the other; a twofold disadvantage is thus presented, in that the liability of contagion or infection is at a maximum, while the wet often causes damage by dripping down from one on to another pupil's clothing. Again, the undue approximation of the pegs may give rise to unnecessary pushing, shuffling, and crowding among the pupils, on entering or leaving school. The advantage claimed by makers of 'portable' stands is that, being on castors, they may be moved in front of the fire—when there happens to be one—to dry the scholars' clothes. In addition to the above drawbacks, there is often placed underneath the hat and cloak-rails a long open box for satchels, bags, etc., thus affording not only an opportunity for carelessness, but also a temptation for disregarding distinctions between the *meum* and the *tuum.*

The following description of an excellently arranged school cloak-room will give an idea of the fixtures that are necessary.

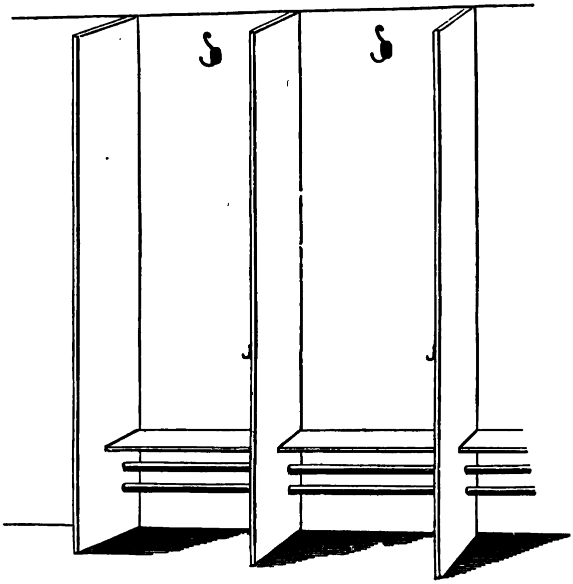

Fig. 15.

Arranged round the room are a series of partitions, each pupil having his own separate compartment, which is numbered; the numbers are to be distinct, and placed preferably a little to the side, so as to be visible even when the hat and other garments are hanging up. In each compartment are two hooks, one in the centre for hanging up outdoor clothes, and another at the side for the umbrella. Below is another ledge for gaiters, etc., and underneath this are the hot-water pipes, running all round the room; while, on the floor, to catch the drippings from the umbrellas, is a slut connected with the drainage outside. A current of air passes into the room through the lower perforated panels of the cloak-room door, its exit taking place by the windows; the damp and disagreeable vapours arising from the clothes, etc., while drying, are thus effectually removed. It is advisable to have a separate room for about every hundred pupils. Fig. 15 will give an idea of the arrangements.

The **sleeping-rooms** are to be used essentially as such, and not for play-rooms. Their closure is desirable throughout the course of the day, when they can be well aired, and during the hours of rest should have a dim, low light burning—a lamp on the principle of the 'Benham,' which cannot be indiscriminately altered, serves the purpose very well. It is essential for the bedrooms to be in the form of dormitories, each containing from twelve to fifteen beds, and never under any conditions in the form of cubicles or small rooms; in the first case, with a head-monitor responsible for the behaviour and security of the remaining occupants, the occurrence of corrupt practices is reduced to a minimum. The amount of cubic space for each scholar is here greater than that required in the class-rooms; a minimum of 800 cubic feet is now necessary. The temperature should be a warm one, and never cold, as has often been recommended on the plea, among others, of making the children hardier. Each child should have its own washing apparatus, and the position of this table against the wall, between each bed, will give the necessary distance of about two and a half to three feet, by which it is well to have the beds separated.

A complaint, far from uncommon, is that the beds are too wide and too short; the size should be regulated by the occupant. If the deficiency be marked, there is a tendency, on the one hand, for the pupil to get into all sorts of cramped positions sideways; and, on the other, to sink downwards, with the head off the pillow. The introduction of cots for the younger children is excellent. Judging from the experiences of travellers, the common position of the body in natural man during sleep appears to be on the back; sleeping on the side is exceptional. When the back is used, the head is supported by some rest, which inclines it a little forward. A warm and soft bed presents great inconveniences, in that its occupant becomes enervated, the sleep is unnaturally prolonged, the muscular system is weakened, and the digestive powers laboured and impaired. Hygienically, there is no absolute reason why hammocks should not be used in preference to bedding; indeed, in the hot summer months they are certainly at an advantage, and under these circumstances light night-costumes might be worn.

No definite rules can be laid down for the necessary length of sleep; this will vary from seven to ten hours, according to age, sex, climatic conditions, and season of the year. Encouragement should be given to the practice of sleeping with the mouth shut, in order to ensure the air being still further warmed and ventilated before reaching the lungs. Another advantage claimed is that this method of breathing serves to retain the mouth in its natural shape, and to lessen the liability of predisposing caries of the teeth from developing itself. The pupils are not to be roused from sleep by the ringing of a loud bell, or beating of a gong, at the door of the apartment; the waking from sleep suddenly and noisily may give rise to deplorable consequences, and even to serious troubles of the nervous system.

The proximity of the night-closet, however well contrived and ventilated, is at all times a source of danger. Let it be removed as far as possible from the dormitory, provided that the passage along which the pupil has to reach it is adequately warmed. On no account is it to be used during the day, and this rule for many reasons has to be rigidly enforced.

The construction of the **school-infirmary** must be devised on plans even still more stringently hygienic than those guiding us in the building of a school-house. Everything must here be perfect. The 'accident' will be kept well apart from the 'fever' wards; thorough isolation is essential, and all attempts at communication between the suffering inmates and their more fortunate playfellows, except by especial permission of the school physician, severely punished. In order that the air of the sick-rooms may be renewed, and at the same time any ingress of air in close proximity to the beds avoided, the following method may be arranged. Pure air let in from outside, after being warmed against the sides of the fireplace and chimney, enters the room from the top; while, to compensate for loss of heat by the walls along which cold currents of air are descending, a system of hot-water pipes is placed all round the room, close to the floor. The system of double windows is here very applicable; the quantity of light should be moderate. The maximum of quiet must be ensured.

The necessity for **instruction in health subjects** and allied matters is apparent: it is better to prevent the children, when well, from falling ill, than attempt to cure them when lying on the bed of sickness. In connection with this subject, the acquisition by the school authorities of what are known as 'ambulance-chests'—the French *boîtes de secours*—is a very excellent plan. These boxes, containing medicines, bandages, and other appliances, are intended as aids to instruction in case of accidents, pending the arrival of the school doctor. The knowledge of the teachers themselves in hygienic subjects is to be ascertained and certified before being allowed to undertake their pedagogic duties.

With regard to **disinfecting arrangements** in schools, Bradford's is a very good example of a fixed or portable apparatus; by its means a damp temperature of from 212° to 250° Fahr. is obtained, under the action of which the destruction of any ordinary disease-germs may be effected. We cannot do better than quote the brief explanation given of it by the inventors. The apparatus consists of a wrought-iron base, divided into three compartments, the central being the heating chamber and the two side chambers being for ventilation, which is regulated through them into the fire-chamber by a series of horizontal and vertical slide-valves. At each corner of this base is securely fixed and stayed a vertical column, surmounted by a pulley, and upon these pulleys, suspended by chains, is a double-case container, made of sheet-iron, with weights to balance it at the other end of the chain, so that it can be conveniently raised from, or lowered upon, the base by one person. The upper part of the base, or heat-generating portion of the apparatus, upon which the container rests when lowered down, is covered with sand, which can be collected for purification immediately over the furnace, and can then be spread over the whole surface, for the double purpose of forming a layer between the container and the base, and also as a non-conducting covering of the base to prevent injury to the fabric. Coarse red, moulder's, or white, sand is found to be the most suitable.

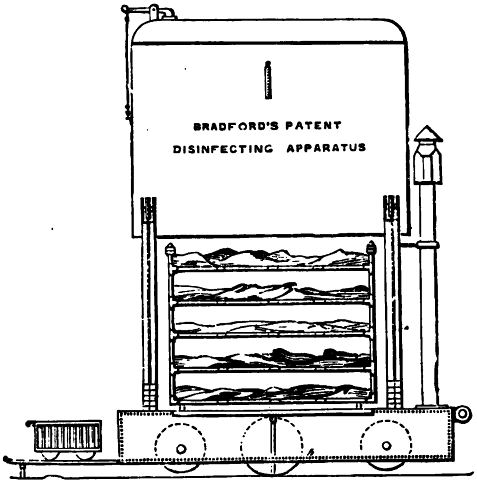

FIG. 16.

Fig. 16 shows the container which forms the disinfecting chamber raised, and the linen placed upon the tubular waggon; the fire waggon being drawn out of the heating-chamber, for preparing and making the fire, with coal, coke, peat, or charcoal; the same waggon being also the receptacle used for placing in an arrangement for heating by gas and asbestos, ready for connection to any ordinary gas service-pipe; the combined arrangement consisting of several sections, one of which can be turned on or off. Fig. 17 shows the end view of the apparatus, with the jointed rails let down, and the tubular waggon, upon which the infected linen is placed, ready for the container to be raised, so that it can be pushed under and enclosed when the container is again lowered. Fig. 18 shows the container with furniture enclosed, ready for disinfection, instead of the waggon with linen or clothing. The heat required for disinfection in the container is obtained from the central or heating chamber; and upon the temperature in the chamber exceeding 212° Fahrenheit steam is then generated by an arrangement of steam-tubes, and also by the tubular waggon, both of which are fitted with the requisite cocks, steam-jets and safety-valves.

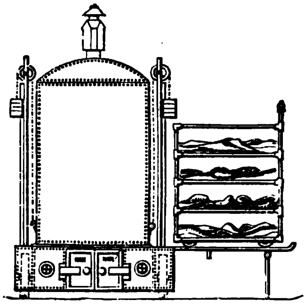

FIG. 17.

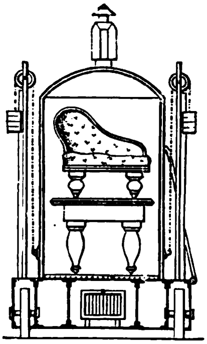

FIG. 18.

Another convenient and very good apparatus, Messrs. Geneste and Herscher's, is one constructed entirely of cast-iron in the form of disjointable panels, so as to render it very portable, and to require but slight skilled knowledge in fixing it up wherever required. Each panel is in the form of a cast-iron box, filled with pumice-stone, a substance well suited to minimise the loss of heat. For a dry temperature, iron pipes, in which water at a high temperature is circulating, cover the walls and floor; for a damp temperature, steam is generated and injected by means of an annexed steam-generator. There is a small waggon ready to receive the various mattresses, bedding, etc.

Passing from the prevention of the spread of infection in schools, to a consideration of the *prevention of disease* itself, the one salient measure that has been proposed and adopted has led to very satisfactory results, notwithstanding the necessarily limited area of its operations. It is a system of carefully organized **medical school inspection,** which is to be compulsory in all schools. The medical inspector under such a system, in addition to his own special acquaintance with hygiene in its widest sense, must have a strong sympathy for children and all relating to their ways and wants, as well as a sound knowledge of education, both practical and theoretical. Among his duties may be mentioned the following:

(*a*) The preparation of maps of the various localities, for the purpose of showing the sites on which schools may be advantageously erected—neglect of which precaution has over and over again proved the source of many an evil—and the careful supervision of the building plans, etc., especially as regards the furtherance of all hygienic requirements.

(*b*) He must give instruction in the elements of hygiene, the necessity and reward of cleanliness, the formation of ambulance classes, and other kindred topics, in so far as they are concerned in the amelioration of human misery and regard for the laws of health.

(*c*) He must make a medical examination of all the teachers and assistants to whom the care of the children is entrusted, in order to ensure their being physically fit for the duties they propose undertaking. He must do his best to dispel popular prejudices, such, for instance, as that against vaccination. His influence in this direction will bear good fruit in the coming generation, by removing those common beliefs in patent elixirs, and other quack medicines.

(*d*) He will undertake similar periodic examinations of the pupils, notices of the outbreak, treatment and progress of disease, and the collation of somatological data. In these tables will be noted the age, place of birth, height, size of chest, strength, breathing-power, the colour and nature of the hair and teeth, information as to the organs of smell, sight and hearing, as well as to any idiosyncrasies. The value of such information cannot be estimated too highly, proving not only of great value in the treatment of future disease, but also in making inquiry bearing upon the predisposition of physical peculiarity to particular disease.

(*e*) He must see to the inspection of the furniture—suitable desks and benches—and of the warming, lighting, and ventilating apparatus of the school-offices, latrines, etc.

It is well if regulations be drawn up for the guidance of both inspectors and teachers, in cases of infection. Thus, in day-schools, those children in whom the inspector recognises symptoms of a contagious nature are to be immediately sent home to the parents with a letter, explaining that the child will not be re-admitted into school without a certificate from their physician to say that its return will prove no source of danger to the other pupils. In boarding-schools, of course, the scholar is immediately removed to the school-infirmary, and isolated. Every schoolmaster and mistress should be provided with a descriptive list of the ordinary contagious diseases and their premonitory symptoms, as well as the necessary instructions in case of minor accidents. In the event of any illness breaking out during the absence of the inspector, the teacher will thus have a tolerably safe means of recognising the ailment and understanding what had best be done.

The advantages of a special **school costume** are that, so far as regards external appearances, it puts on an equal footing the children of the wealthy and of the poor; further, that in the case of day-schools, the dry clothing, dry boots, etc., will ensure immunity from the effects of any inclemencies of the weather, encountered while coming to morning school. In the latter case, the change from ordinary civilian costume will minimise the chance of unintentional introduction into the school of any infectious disease. In summer, only clothings which are good conductors of heat, and of a close 'web,' should be used. They must be light and airy, so as to permit of a free circulation of air, and fitted so that all free motion of the limbs may nowise be hindered. Thus with girls, in the case of the chemise, which is open in front, the armholes are circular at the top and elliptic near the armpit; or instead of the ellipse, a gusset may be inserted. In the flannel vest, also, the armholes are well cut out over the shoulders. Bad conductors, such as wool, are necessary in the winter-time; the custom of adding another and another article of attire, in direct proportion as the weather gets colder and colder, is to be strongly deprecated. Warmth and weight must be kept separate. Anything too tight should be conspicuous by its absence; tight cravats, collars, boot-strings, lacings, etc., all tend to constrict the bloodvessels, and thus impede the circulation. Stockings can be kept in position by means of suspenders, attached to the circular bands, which will be described later on. The costume can be simple, and at the same time neat and becoming. The colour and nature of the cloth will vary with the season of the year; the weight, which must be kept at a minimum, should as far as possible fall from the hips, and not from the shoulders. This is effected by means of circular bands, of which the following description, so far as regards girls, will suffice. *On* the hip, and *not above*, a circular band is fixed, which is so wide as to come to the groins, and fastened behind higher up by three buttons; the upper edge is slightly scooped out to an inch lower than the hips, and the circle which it forms at the top of the band is much smaller than the circle formed by the lower edge, from which the folds of the petticoat are hanging down; this arrangement prevents the slipping down of the petticoat. In some cases, triangular pieces can be inserted, so as to increase the circumference of the lower edge of the circular band. A similar circular band is used for drawers, with this difference—that the band is opened on both sides and fastened by two buttons on the hip. Stays may be worn conditionally on their allowing of the full respiratory movements, and not acting as a support for the dorsal muscles.

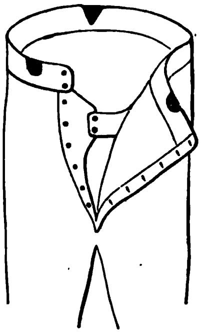

FIG. 19.

Turning our attention to boys, an imitation circular band is made use of (see Fig. 19). For this purpose an elastic band inside the trousers, from one side to another, corresponding to the hip-bone, is connected on the right side with a flap, cut with the trousers, while on the left a linen flap is sewn to the seam of the trouser; both flaps in front are a few inches lower than the elastic band, and are fastened on the left side about three to four inches from the left hip. The pressure being on the hip-bone, about an inch below the highest point, and the front part formed by the flaps being scooped, no pressure is exerted on the abdominal organs, and the trousers are fixed by the circle formed by the elastic and the flaps, even before they are buttoned in front. The advantages of these trousers are, that braces not being wanted, there is not the slightest drag on the shoulders, which often causes a discomfort, and induces the wearer to make frequent and involuntary movements. The chest is perfectly free, the respiratory movement not in any way interfered with, and there is no abdominal pressure, because the trousers being fastened *on* the hip-bone, the pressure is only *on* and not *above* the hip-bones. The head is best protected by a light covering with broad brim, which will especially protect the back of the neck from the sun's rays; at other times ear-protectors may be necessary. The hat is best made of soft, flexible material; from the pernicious habit of school-children throwing their hats at one another, all hard shapes and all beak-caps (the French *képi*) are to be avoided, serious injury to the eyes being often the result of neglect in this direction. The imposition of a fine, or other punishment, is advisable in cases of the scholar wearing another's hat. With regard to boots, high heels are never to be permitted, and the boots themselves are to be so shaped that the inner border from big toe to heel should be in one same straight line, the natural shape of the foot (Fig. 20). A very good plan is to wear digitated socks, a habit which not only promotes cleanliness and coolness between the toes, but also arrests any deformities resulting from their chafing or compression one against the other.

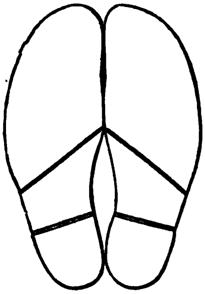

FIG. 20.

It is impossible to lay down any fixed rules as to the nature and dressing of the **Food**—qualities dependent on the locality, season, and individual taste; but, that it should be abundant, wholesome, and relishing is a *sine quâ non.* In warm weather the supply of vegetables and fruit must be increased, and the meat and fatty foods diminished; in cold climates, on the contrary, there is a necessity for a preponderance of fatty, fibrinous, and oily foods. Whatever drink is taken, let it be always in small mouthfuls, rather than in long draughts. Tea, coffee, beer, or alcohol, are unnecessary, though under special circumstances, and in moderate quantities, harmless. In the choice of dishes, do not neglect the special taste for any particular food; in some special cases the taste has even to be educated. As far as possible, let a limit be placed on the number of dishes: the stomach, however strong, does not too readily accommodate itself to any complicated chemical reactions.

'Without in any way advocating a purely vegetable diet, there is not the slightest doubt that the more general use of the staple foods—wheatmeal, oatmeal, barley, lentils, haricots, peas, etc.—with the addition of fresh fruits and vegetables, will enable children to grow up strong and healthy with but a small supply of high-priced animal food, and will also greatly promote the general health of the community.' The spreading of a knowledge of the foods that nourish completely, at the least cost, is a want widely felt. The physical qualities of the comestible is likewise of importance, and the habitual indulgence in soft foods may often give rise to looseness of the teeth, from want of exercise. Indeed, the decay of the teeth amongst Americans has been attributed to the perfection of their machinery, which completely separates the external parts of the grain, and makes the flour exceedingly fine and white. It has been supposed that the constant use of fine flour tends to premature decay of the teeth, owing to the want of sufficient proportion of lime-salts. The dining together at the same tables, and sharing meals in common with the masters, is desirable from many points of view; for instance, that the usual hurrying over the repast may be prevented, order, decency, and cleanliness may be maintained, and the proper quality of the food supervised by personal experience. The interval between meals must not be too long. With regard to training for athletic and other sports, the following few notes will comprise all that is essential to bear in mind. The one great fault in training that has prevailed hitherto is its empiricism. 'In spite of the dogmatic assertions of trainers to the contrary, fat and sugar may be freely taken as they present the type of food most valuable to those who wish to store up energy, as well as to sustain the animal heat. An old fad of trainers used to be, that drink must be restricted as much as possible, because it produced "internal fat," and thus impaired the wind. No one, however, has been able to demonstrate where this dreaded "internal fat" is placed; and its existence being mythical, it is not therefore necessary to guard against its accumulation, fluid being allowed in due quantity to repair the wants of the system. Hard bodily exertion is best done without alcohol. If any stimulant seems to be required, let it be taken with the last meal, in the form of a little light beer.'

So far as the **drainage** question of the school-house is concerned, the literature bearing on the subject is enormous, and it would be out of place to discuss *in toto* the many systems, excellent and otherwise, that have been resorted to, in order to remove the fecal matter as cleanly and speedily as possible. However, there are some special details of construction requisite for school purposes that do not fall under the scope of an ordinary treatise on house-drainage. It is the opinion of several English authorities that the best situation of the closets is such that they be built one over the other as a projection from the house; this is no doubt convenient so far as building-construction goes, but, unless heated by special apparatus, unsuitable for the low temperatures often met with. Excepting of course the night-closets, it is more advantageous that they should be removed, whenever practicable, to a considerable distance from the school-building, yet at the same time connected by a covered way that may be adequately lighted, ventilated and heated during the winter months. For ten scholars, one closet and one urinal should be provided. The closets should all be partitioned off, so that each closet may in no case be capable of admitting more than one child at a time; and with this end in view, and also to minimise space, the doors should open outwards. The practice, at certain continental schools, of having the doors constructed in such a way that the head and feet may be visible, is unnecessary and unsuitable for the English-speaking peoples. It is advisable that all the walls be made of tiles or of other hard-glazed substance, whereby the habit of indecent scribbling on the walls is prevented, and which at the same time will easily allow of their frequently being washed down with water.

The dimensions of the seat will vary with the average stature at different ages; to prevent cold, and the liability to piles, the warming of the seat is very advantageous. The objections arising from the use of the ordinary closets among children are of a double nature:

(i.) The plug in being used is liable to disorder or damage; and

(ii.) Its use is carelessly or wilfully forgotten.

For the purpose of remedying the former, a press-knob handle may be employed; while to obviate the latter, an automatic mechanical or a flushing apparatus, according as we have to deal with an earth or water closet, is very advantageous.

Provided the house-drainage itself is good, there can be no doubt that when the use of an abundant supply of water, coupled with a good sewer and fall can be obtained in the neighbourhood, the system of water-closets is the better, in that the liability of foul smells accumulating is reduced, the speedy removal of the excreta ensured, and the 'onus' of its final destination handed over to other authorities. On the other hand, when the surrounding conditions do not admit of the above requirements, dry-earth closets are far superior to any of the other arrangements.

By '**scientific physical education**' is understood the inculcation of the elements of hygiene, combined with the practice of simple though scientifically devised exercises, founded on sound physiological and anatomical principles; its aim and object is the harmonious development of the mind, simultaneously with that of the body—the one is never to be developed at the expense of the other.

Such an education is not to be confounded, as unfortunately it only too often is, with drilling, calisthenics, athletics, or gymnastics, in the sense ordinarily applied to it. Thus, in the matter of drilling we 'only degrade physical education, and defeat the very object we wish to attain, of preparing the whole male population for military services, by calling in prematurely the aid of the drill-sergeant, in the case of children, who require a whole course of preparatory training, in order to make them of the best use in the drill-sergeant's hands.' And were we to inquire into the fitness of the ordinary individuals as instructors in these accomplishments, the adequate knowledge of anatomy, physiology and hygiene would be only conspicuous by its absence. The ignorance of such a teacher under existing circumstances is excusable, even if the instruction be productive of injurious results: for with regard to the movements and exercises themselves, the ordinary instructor has no means of satisfying himself as to the competence of the scholars to perform them, or, even if this point be assured, as to the suitableness of the exercise, and the physiological effects liable to be produced in each individual case.

Scientific physical education must be compulsory in all schools, both girls' and boys': great good would result if both sexes, up to the age of fourteen or so, were to undergo their physical training together, and indulge in the same ordinary outdoor recreations.

The persistent opposition with which the introduction of this kind of education into schools has often been met, is to be explained chiefly by the general and wide-spread ignorance of the meaning and importance attaching to this special branch of knowledge. Another factor to blame is the prevalent idea that such instruction is not requisite in face of the numerous outdoor sports; the individuals who use this argument forget that these outdoor recreations and amusements are in great measure confined only to certain, and these not the major, portions of the community, and think it is a sufficient excuse if a few classes of the State are really devoted to these exercises—the large majority is left out of account.

There can be no doubt that this question of scientific physical education has a most intimate bearing on the maintenance of a good physique among the population, on the prevalent comparatively high death-rate of children, on the amount of preventible disease, and on the ignorance, ill-will, or prejudice with which, even by 'educated' people themselves, all sanitary measures are carried out.

The mistaken view of the advocates of *athletic sports*, that by such a scientific physical training is intended an antagonism to those forms of exercise, has asserted a most injurious influence; its champions do not know that this education would act as an invaluable adjunct, would help to improve the general well-being of the scholars, and tend to weed out, for suitable treatment, those who are physically unfit to indulge in them.

It is, of course, impossible to discuss here the relative merits of all the various schemes of scientific physical training that have till now been brought forward; but it cannot be too much to say that any scheme is good, provided that it is founded on sound physiological and anatomical principles, and applied by thoroughly competent individuals. Ling's, or the Swedish system, is the one that most nearly fulfils these requirements; the German system, as has been well described, is rather a scheme, 'that has grown bit by bit, than been evolved as a system, founded on a scientific knowledge of the human body.'

Ling's system, the oldest and without doubt most thorough and complete, is divided into four parts, to meet the requirements of educational, æsthetical, military and medical purposes. In the first, or 'free exercises,' no gymnastic apparatus whatever is required; they are perfectly sufficient, when rationally applied, for the harmonius development of the body. (To the popular mind, no school gymnasium is considered complete without dumb-bells, horizontal bars, or other similar contrivances.) The æsthetical part is intended to teach the expression of ideas and sentiments, by means of positions and movements, and is of great use for actors, orators, painters, sculptors, etc. The 'military' portion is based on the pedagogic branch, to which are added sword, foil, and bayonet exercises. The 'medical' or movement-cure comprises special exercises devised for the treatment and cure of many chronic diseases and deformities; it consists of free movements, with or without assistance or resistance, of movements with special apparatus, and of passive movements, usually called 'manipulation.'

A lesson to the pupils in the 'free exercises' is characterized by its rational simplicity; thus, beginning with head-movements, we proceed to those acting on the arms, the trunk and the legs—the whole being varied, at due intervals, with a few minutes' rest, or play—and end with the so-called 'soothing' movements. The introduction of music, and thus the maintenance of regular rhythm in the exercises, is extremely salutary and advantageous. The movements of swimming should also be taught, so that whenever there are opportunities, they may be taught to swim.

But before leaving this important question of the training of the body as a whole, something must be said concerning the equally neglected one, of the physical training of the body in relation to its surroundings—the *physical culture of the senses.* Hitherto such instruction has, in the main, only been imparted for curative purposes, and as a remedial measure; but it is now proposed to have it included as a branch of general education. Thus, Vision must be educated for the purpose of distinguishing various colours and their shades; also the form, distance, and heights of the objects seen. Touch is to be developed with regard to smoothness or roughness, and the various inequalities of a surface; a collection, somewhat of the following, will prove of good use: velvet, linen, fur, cotton, silk, satin, glass-paper, etc. The senses of Taste, Smell and Hearing are to be similarly physically educated.

Passing now from general rational gymnastics to special, we may mention that *singing* should be looked upon as a form of gymnastics, and be made compulsory. 'Not only does it encourage a musical taste, which might otherwise have remained dormant, but it develops the larynx and the chest, it improves the voice for public-speaking, and it adds to that moderate amount of self-confidence which is so necessary to ensure success in any walk of life.'

Apparatuses have been devised for the purpose of increasing the strength, delicacy, and flexibility of the fingers, with a view to better musical execution: they are usually constructed on two types—in the one a resistance has to be overcome, in the other a pressure has to be applied.

Should, however, we wish to train our children as gymnasts, or acrobats, it is always easy to provide them with the ordinary bazaar-element appliances, on which, as often as not, they will be enabled to give expression to their love of sensational display.

Under various systems of physical training, special machines have been invented for saving the energies of a manipulator in carrying out the special exercises that may be required. Such machines, when rationally applied, are very good in many passive movements, but of little or hardly any use in 'active' ones, for the reason that the resistance, whatever it may be, is a constant throughout the extent of that movement, and is not capable, during its extent, of increase or decrease according to individual requirements: another objection which must not be lost sight of is, that there is one, and only one, definite 'commencing position.'

It is beyond the scope of the present little work to tabulate the various offences for which **punishment** is liable; but from the hygienic point of view, the following suggestions may prove of service. The teacher must remember that in young children the faculties for activity and imitation are comparatively at their greatest development: hence, great indulgence for restlessness, etc., should be exercised. In older scholars, no form of punishment should be permitted which in any way tends to injury of the physical or mental health. Of the custom of keeping boys in at a 'task' during play-hours, it is needless to say more than that it is a most senseless and harmful one, in that the poor culprit is deprived of his necessary amount of physical exercise, the loss of which dulls him for anything else he may have to do subsequently. 'We may point out to the educational authorities the importance of bearing in mind that stupidity, or peculiarity of manner, or apparent dulness or disrespect, may be due to physical causes, to bad air, want of food, or incipient brain-disease, or bad sight, and that medical treatment rather than harsh discipline may be required.' The plan adopted in many English public schools of having the minor offences settled and punished by a special committee formed of the sixth form or senior boys is very good, so long as everything is reported to the head-master. But if, when all else fails, corporal punishment must, as the very last resource, be inflicted, it should always be administered by one person, with the knowledge and consent of the parents, and in the presence of the school physician. Hitting on the head and boxing the ears are most dangerous practices; the latter has often caused a rupture of the tympanum, and even permanent deafness. It would be beneficial alike to master and pupil if some system of punishment could be devised whereby the moral degradation and publicity of shame would prove of greater potency than actual physical pain.

In the majority of cases, the **distribution of school-hours** and the time taken up in preparation-work leaves much to be desired; it is indeed difficult to arrive at any satisfactory solution of the question, depending as it does upon the season of the year, the competition, and the individual constitution. All the dangers of over-pressure may be avoided, or at all events greatly mitigated, by the due observance of hygienic conditions.

'Physiologists who have studied the educational relations of their subject (and happily these yearly increase in number) have investigated the length of time during which a child can healthily give continuous attention to one subject at a time. As formulated by Edwin Chadwick, and endorsed by physicians, they have arrived at the following conclusions: That from five years of age to seven, a child can attend to one subject—that is, to a single lesson—for only fifteen minutes; from seven to ten, about twenty minutes; from ten to twelve, about twenty-five minutes; from twelve to sixteen or eighteen, about thirty minutes; and that the total amount of work that ought to be exacted from any one in a day should not exceed a maximum of ten hours for young men, grading downwards to two and a half to three hours a day for children under seven.'

Of course the evil of over-pressure is carried on to the greatest extent in day-schools, where the amount of time taken up in the preparation of home-work is a matter of perfect indifference to the ordinary teacher, who is satisfied so long as he finds the lesson prepared; the remedy is to be sought in the system of preparing all the next day's lessons in the school, under the supervision of the master, who would thus in addition acquire a greater inkling into the capabilities of his pupils.

It is impossible for the child to go through the same amount of mental exertion in summer as in winter; and it is a grave question whether, in the former portion of the year, afternoon work ought not to be altogether stopped.

The system of holding summer **examinations** is also to be deprecated, and competition must be spoken of in unfavourable terms, especially in the very young; even among children a little older, the fear and anxiety depending on the results of an examination are often most pitiably marked. If such a test be imperative, it were much better for the children to be examined always by their own teacher, and in the presence of some one who, while at the same time giving sufficient testimony to the fairness and correctness of the examination, could in no way be influenced by its results.

Lessons.*—The importance of frequent intervals in school-work cannot be too much pressed: there should be an interval at the end of every hour of the school-day for the children to get out into the open air, to romp about; it need not be long, but it ought to be provided without fail. The central principle in the use of frequent intervals is the fact on which all organisms are based, that mind and body are in a constant state of change, which necessitates variety of employment; and that the brain, being imperfectly developed in a child, is incapable of sustained effort in the same direction for any length of time without detriment. Continual change of effort is necessary for a healthy development of both body and brain, and concentrated attention in one direction for too long a period involves possible danger; and the younger the child the greater is that danger. We can thus recognise the need and wisdom of the regular use of what may be called 'alteratives' in all our school-work. The most obvious of these is that of frequent change of subject, guided by the principle that the subjects successively studied should exercise faculties as diverse and contrastive as possible, for the sake of relieving the faculties already employed, and exercising those that have been more or less idle. This should be the chief consideration in constructing time-tables of work for any class. Most lessons should be shorter than they generally are; physical exercises should be regularly and frequently interpolated. The continual renewal of interest during work is an invaluable vitalizer; much of school-study that must be gone through is dry and dull, and no means should be neglected to dispel *ennui* and create pleasure. Nothing creates interest better than the wise and pleasant exercise of intelligence in all subjects, even the dullest. The preservation of the cheerfulness and natural vivacity of children in school-work is of vital importance to training and success: its suppression is a grievous mistake, both physical and mental. No child can be truly and healthily developed without gladness, any more than a plant without sunshine—so both physiologists and educationists tell us. But this cultivation of cheerfulness might well and wisely be carried further than even genial schoolmasters seem to think possible. The greater use of humour and laughter in all school-work is desirable, both as an alterative and as a trainer of neglected faculties. Children bring cheerfulness and mirth as a natural gift into school, provided these have not already been suppressed by an unnatural education. It would be better for all schools if they were not suppressed when they enter these, but developed and utilized for educational ends. The over-strict silence exacted in some schools is simply painful; it is the suppression of joyousness and the product of fear, and is incompatible with healthy influence. Finally, we should guard ourselves against the over-use of memory, which is a physical suppression and evil, as well as mental. What is generally called memory is merely verbal memory, or the memory of the faculty of language, and it is this faculty which is so much abused in school-work. Here it is that we have more real 'over-pressure' than anywhere else in all school-work: we ought to employ the faculties of perception, observation, comparison, and reasoning, as the greatest instruments of our training; and these, by their very exercise, would become the real memory whose services we so much desire in the production of 'results.'

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* The following paragraph is an abstract of an excellent article on the 'Physico-mental Violations of School-life,' by W. Jolly (see *Bibliography*).

There is no more effective or delightful renovator of waning energy than **Music.** No teacher in any class who is capable of singing should pass almost any hour without a bright burst of sweet and joyous song. No teacher should certainly be appointed to an infant-school anywhere who cannot sing; and yet this is not uncommon. The teacher that does not use music as a battle-march for his youthful army is throwing away his choicest means for victory.

But granted that all the conditions which have been advocated and suggested in the foregoing pages are present in our model school, there are other requisites still more potent and necessary to keep all this proposed and complicated machinery at work, and maintain it in repair. For this purpose the following considerations concerning the attitude and relations of the public in general, and teachers and pupils in particular, may not prove out of place.

Under present arrangements the public has no special guarantee of the efficiency of a school (except, perhaps, a few testimonials of some scholars' parents who have never been inside it) beyond inductions based on so many passes at such and such examinations. The **formation of museums** for the exposition of everything relative to school hygiene is a step in the right direction, and will tend to greater elucidation on this subject. The masses of the people are labouring under a delusion in determining a standard of school-excellence founded on the relative intellectual development of a minor percentage; it would be almost as sane to measure the efficacy of a teacher by the number of square yards included in the school-site. But since the belief is of so deep-rooted a nature, and apparently vindicated by the social conditions and official necessities among which the people are educated and reared, the assistance of State-aid must be resorted to. What is wanted is a system of **compulsory licensing and registration of all schools**, both boys' and girls'. Such a register, in addition to the different notices of intellectual achievements, would include the reports of the medical inspector, not only on any suggested improvements in the school-fittings and construction, but also his notions on the health, general physique, and moral welfare of the scholars. To many of the schools at present existent a license would be immediately granted; to others, conditionally on their carrying out various proposed alterations; while the bad schools would thus be soon entirely obliterated. It may be stated that the adoption and carrying out of this measure is far from savouring of a Utopian nature: the laws with regard to the prevention of cattle-disease were as strenuously opposed as they were subsequently enforced and vindicated; and surely the prevention of child-disease requires a somewhat greater consideration.

With regard to **the teacher**, it were well if all thoughts of pecuniary gain could be effectually prevented from influencing him in the choice of his profession. The relations of master and pupil should be maintained in as spotless an integrity as those existing between the ideal father and son. All emolument arising from ownership of a 'house' in English public schools, for instance, from the possession of shares in certain of the so-called school companies, and from other kindred sources, must be reckoned up with dubious satisfaction. The same may be said of the method of fixing the master's salary by the results of his scholars' examinations: over-pressure may prove the disastrous effect. A common complaint often, and with reason, brought against the master is his inability to teach. He may be the most brilliant student of the classics, he may prove the hardest worker in the mathematics—yet of what use is this in imparting knowledge to those placed under his charge? The teacher is to be taught to teach. 'The first good quality of an instructor is to be healthy, and to be able to take care of his own health; many sickly and weak school-masters and mistresses prove the deficiency of these most important qualities, a deficiency which reacts very badly on the pupils.'

The **pupils**, when first sent to school, should be in the best condition of health, an indispensable requisite for competency to admission.

The object of an ordinary school education being not only a preparatory training for perhaps ultimately the higher schools and universities, but eventually for physical fitness and intellectual ability in carrying out the social requirements of everyday life, we may consider one or two of the special requisites necessary for meeting with any natural, and at the same time possible, contingencies. With regard to boys, the fitting-up of a **carpenter's shop** will well repay the cost of any labour that may be bestowed upon it: under the superintendence of a competent person, the scholars may utilize their handiwork in the refitting of any woodwork, etc., in the school-building itself. Girls should think it in no way derogatory to take their turn in lending assistance and learning all that concerns the housekeeping and cooking departments. In all finishing schools and training colleges for women, there should be attached a **model nursery**, where instruction concerning the rational management of babies and infants may be imparted; the prevailing ignorance of the gentler sex on these matters is notorious, and is one of the chief causes of the unnecessarily high death-rate of children.

Special Schools.—In the same way that the blind have special institutions for their educational welfare, all consumptive, rickety, and otherwise deformed children, must be sent to the respective schools for those complaints; they must be refused admission into the normal schools for healthy scholars. This refusal must be regarded in the proper light as a work of mercy and of charity, in that their presence in the common schools is liable to be productive of contempt, of feelings of inferiority, and of ill-treatment at the hands of others, and of a want of sympathy, kindliness, and protection as regards themselves. Strong arguments have even been brought forward for the annexe to the ordinary buildings of a special school for 'backward' pupils. On the other hand, no matter their creed, race, social position, or birth, all the healthy have the right to come: it is only by the very justness of such a measure that the school hygienist will be able to grapple with, and perhaps subdue, those several prejudices which, if left undisturbed, it may be found impossible to overcome in maturer years.

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